Bacteriological Assessment Of Drinking Water Sources In Opuraja Community of Delta State, Nigeria

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ABSTRACT: This study aimed at assessing the bacteriological quality of the drinking water in Opuraja community of Okpe Local Government area, Delta State, Nigeria. The total heterotrophic count ranges from 1.45×10^3 to 1.5×10^6 for all sources of water. The MPN values of the water samples ranged from 2 to 17 MPN/100ml. The total coliform count of water samples ranged from 14 to 198 MPN/100ml and the faecal coliform count ranged from 5 to 56 MPN/100ml. The temperature ranges from 22 to 28^{o}C. The pH varies from 5.0 to 7.6 which are quite acidic. The bacteria isolated were *Escherichia coli*, *Salmonella* sp., *Shigella* sp., *Citrobacter* sp., *Proteus* sp., *Klebsiella* sp., *Vibrio sp., Bacillus* sp. *and Enterobacter* sp. All the water sources fell far below the standards approved by WHO and NAFDAC. The isolation of *E. coli, Salmonella* sp. and *Vibrio* sp. in this study is an indication that if not check an outbreak could occur in the near future.

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1.0 INTRODUCTION

Sources of drinking water include streams, wells, rivers and lakes mostly in villages. The streams, rivers and lakes which are sources of drinking water are use as sewage disposal site. The usual sources of drinking water is the streams, rivers, well and boreholes which are mostly untreated and associated with various health risks (Okonko et al., 2008a, b). Water provides essential elements, but when polluted it may becomes undesirable substance dangerous to human health (Karavoltsos et al., 2008).

Many infectious diseases are transmitted by water through the fecal-oral route. Unsanitary water has particularly devastating effects on young children in the developing world. Each year, >2 million persons, mostly children <5 years of age, die of diarrheal disease (Kosek et al., 2003; Parashar et al., 2003; Okonko et al., 2008b). According to Shittu *et al.* (2008), water is vital to our existence in life and its importance in our daily life makes it imperative that thorough microbiological and physico-chemical examinations be conducted on water. The quality of water influence the health status of any populace, hence, analysis of for physical, biological and chemical properties including trace element contents are very important for public health studies (Shalom *et al*., 2011).

Portable water is the water that is free from disease producing microorganisms and chemical substances that are dangerous to health (Lamikanra, 1999). The ingestion of water contaminated with pathogens (Onoja and Adelakun, 2009) has manifestated in diseases like typhoid fever, amoebic dysentery and cholera etc which has resulted in deterioration of health and in some cases death (Isikwue *et al*., 2011). Shittu *et al.* (2008) also put it that in Nigeria majority of the rural populace do not have access to portable water and therefore, depend on wells, streams and river water for domestic use. The bacterial qualities of groundwater, pipe borne water and other natural water supplies in Nigeria have been reported to be unsatisfactory with coliform counts for exceeding the level recommended by WHO (Dada *et al*, 1999a, 1999b, Edema *et al*, 2001).

No report of the bacteriological quality has been reported on the water quality of Opuraja Community (as a case study) Mereje Clan, Okpe Local Government Area of Delta State, where more than half of the populace disposes their sewage at backyards. The aim of this study is to evaluate the bacteriological quality of drinking water sources in Opuraja community, a rural area in Delta State, Nigeria.

2.0. MATERIALS AND METHODS

2.1. Study area

The study area is located in Okpe Local Government Area in Delta State which lies between latitude 5^{o}31'N and 5°35'N and Longitude 5°29' and 5°48'E. Opuraja bounded to the North by Jakpa community, to the West by Iriama community, to the East by Adeje community and the South by Kpokpogri community.

Opuraja is situated within the Niger Delta region of Nigeria, which has the Agbada, Akata

and Benin Formation. The rocks found are of sedimentary types having silt, clay and sand to top layer (4-6m). This is followed by a thick (up to 17m) layer of silts to the top but becoming coarse and pebbly at below depth (Okoye et al., 1987). Both places have a flat terrain of about 6m above sea level (Barbour et al., 1982). The area is also characterized by hydromorphic soils, which is a mixture of course alluvial and colluvial deposits (Okoye et al., 1987 and Efe, 2002). Thus, reflects the rate of percolation and infiltration of water into the soil.

2.2. Climate and Vegetation

The area is characterized by tropical equatorial climate with mean annual temperature of 27.440C and rainfall amount of 275.21mm. Rainfall period ranges from January to December, with the minimum value of 20.4mm in January and over 499.1mm in September. However, double rain maxima between the months of July and September are observed. There is a little day spell in the month of August called August break. Convectional type of rainfall is predominant in the community. The predominant wind system in Opuraja is the tropical Maritime Air Mass (mT). This air mass is humid and moist, and brings rainfall into this environment. The influence of the Tropical Continent (cT) air mass is minimal; it brings in slight harmattan in the area between December and February. The natural vegetation is of rainforest with swamp forest in some areas. The forest is rich in timber trees, palm trees, as well as fruit trees. Unfortunately, much of the rain forest has been destroyed as a result of farming, commercial lumbering and urbanization. However, it is still a fairly large area of swamp forest vegetation.

2.3. Sources where samples were obtained

The samples were collected from wells, taps and streams at Opuraja Community in Mereje Clan Okpe Local Government Area Delta State.

2.4. Physico-Chemical Analysis

The temperatures were determined instantly using mercury-in-glass thermometer and recorded. The pH of these samples was determined immediately the samples were brought to the laboratory. A potable pocket-sized ph meter (manufactured by Hanna Instrument with specification of 0.0 to 14.0ph range, 0.1ph resolution and ±0.1ph accuracy) was used. The colour, taste, odour and presence of particles were analyzed with the sense organs such as the eyes, tongue and nose. All samples were brought to the laboratory within 6 to 8 hours of collection and preserved in the fridge before analysis.

2.5. Bacteriological Analysis

In the bacteria isolation, nutrient agar, MacConkey agar, TCBS, EMB and SSA were used. MacConkey broth powder was used for the MPN test. All media were prepared and sterilized as instructed by manufacturer. Glasswares were sterilized at 121^{o}c for 20mins. A 10-fold serial dilution was carried out and dilution factors used were 10^{-1}, 10^{-2}, 10^{-3} and 10^{-4} depending on the source of water. Enumeration of total heterotrophic bacteria was carried out as described by APHA (1999). The nutrient agar medium (FLUKES) was used for the enumeration of THC and was prepared to the quantity needed following the manufacturer's instruction. A 0.1ml of each of the dilution factors was plated out and spread evenly with a sterilized spread rod. The plates were incubated at 35^{0}C for 24h and the THC of samples was recorded.

The most probable number method (MPN) was used to analysis total and faecal coliform count (APHA 1999). The procedure for total coliform was also carried out here only that the presumptive tubes were incubated for 48 hours. Yellow colouration and gas production in Durham's tubes indicated positive result. For the completed test, positives were streaked on Eosin Methylene Blue (EMB) agar and incubated for 24-48 hours at room temperature. Thereafter, morphological, cultural characteristic and biochemical tests were carried out for identification of the unknown organisms. Discrete colonies which were developed from the cultured organisms were picked using a sterile wire loop and were aseptically sub-cultured into freshly prepared nutrient agar plates to obtain pure cultures and incubate at room temperature or 25^{0}C for 24 h. The further identification of isolates was done using morphological, physiological and different biochemical tests. The isolates were identified by comparing their characteristics with those of known taxa, as described by Jolt *et al*. (1994) and Oyeleke and Manga (2008). Following these tests, the isolates were identified (Sneath *et al*., 1986).

3.0. RESULTS ANALYSIS

A total of 20 samples of water were examined. Samples Aww-Lww refers to well water samples from different locations in Opuraja community, samples Mtw-Rtw were water samples from taps while Stream and Tstream were water samples collected from stream.

3.1. pH values of the water samples

From the physico-chemical analysis, the pH values of the water samples were quite acidic and slightly alkaline in values range from pH 5.0 to 7.6. Samples, Cww and Nww have the highest of pH of 7.6 and 7.2 respectively, which were in the neutral state. This finding supported the pH values recommended by WHO (1995) and APHA (1985). According to Medera et al. (1982) and Okonko et al. (2008a), the pH of most natural waters range from 6.5 - 8.5 while deviation from the neutral 7.0 is as a result of the CO_2/bicarbonate/ carbonate equilibrium. The pH of brackish water bodies stated by Imevbore (1985) ranged from 6.5 - 7.4.

The tap water samples have pH range from 5.0 to 5.8. This is the water the inhabitants drink most. The high acidic contents of the water samples could be attributed to the delay of the outbreak of cholera in the community because acidic environment do not support the growth of *Vibrio* sp. This supports the finding of Charles and Angelo (2004) that *Vibrio* sp. grow best under alkaline condition. In a study by Okonko et al. (2008a), the pH of water samples for domestic uses in Abeokuta ranged from 5.51 to 8.01. The generally low (acidic) pH values obtained in some water samples might be due to the high levels of free CO2 in the water samples, which may consequently affect the bacterial counts. This was also reported by Edema et al. (2001). The pH of water is extremely important. The fluctuations in optimum pH ranges may lead to an increase or decrease in the toxicity of poisons in water bodies (Ali, 1991; Okonko et al., 2008a).

The pH of wells water lied within 6 and 7, and the inhabitants of the community drink from it when there is prolong power failure. This implied that the source of power to the bore-hole water supply is the PHCN (Power Holding Companies of Nigeria) formally NEPA. To avoid the outbreak of cholera in the nearest future, PHNC should provide power constantly and the inhabitants on their own part should cultivate the spirit of maintaining the pipe water facilities.

3.2. Temperature values of the water samples

In this study, the temperature ranged from 22 to 30^{O}C. This is similar to what was reported by Okonko et al. (2008a). The water body is believed to have been influenced by the intensity of the sunlight as temperature rose from 28 - 30^{O}C on relatively hot days (Mulusky, 1974). This was also reported by Banwo (2006). Alabaster and Lloyd (1980) also reported a temperature ranges of 26 and 30^{O}C in a similar study and attributed it to the insulating effect of increased nutrient load resulting from industrial discharge.

3.3. Total heterotrophic count (THC) of drinking water

Table 1 shows the total heterotrophic count (THC) of drinking water in Opuraja community, Delta State, Nigeria. The result showed that the different drinking water sources are highly contaminated because of the total heterotrophic count (THC) which ranges from 1.6×10^{3} to 1.5×10^{6} which are far more than the recommended value of 1.2×10^{2} of WHO (1995) and FAO (1997).

3.4. Total and faecal coliform count of drinking water

Owing that the total and faecal coliform count of these water samples was grossly contaminated. Recommended standard for water is less than 2MPN 100 ml (FAO, 1997). The very high contamination may be due to the non-hygienic disposal of fecal waste in pit and open toilets at the back yards of the inhabitants by the inhabitants. The high contamination level may be due to time of the study (August-October, 2011) which are months of rainy season as a result the seepage of water contaminated with bacteria to aquifer will surely occur as recorded by Isikwue *et al.* (2011).

The presence of coliforms in these water samples (Table 2) generally suggests that a certain selection of water may have been contaminated with faeces either of human or animal origin (Okonko et al., 2008a). Other more dangerous microorganisms could be present (Richman, 1997). This result compared favourably with the report of Banwo (2006) which indicates that the presence of bushes and shrubs makes likely possible that smaller mammals may have been coming around these water bodies to drink water, thereby passing out faeces into the water.

Table shows the total and faecal coliform counts (MPN/100ml) of the drinking water samples from Opuraja Community, Delta State, Nigeria. The total and faecal coliform colonies counts were of extremely high values ranging from 14 to 198 MPN/100ml and 5 to 68MPN/100ml respectively. This is an indication that the sources of drinking water may be prone to pathogenic organism like Vibrio, salmonella etc which were isolated in the course of the research. These values deviated from the standard recommended by WHO which are 0 MPN/100 ml and 10MPN/100 ml of coliforms (WHO, 2004; NAFDAC, 2004).

Table 1: Total Heterotrophic Count (THC) of drinking water in Opuraja Community, Okpe LGA, Delta State, Nigeria

Samples	CFU/ml	Samples	CFU/ml
Aww	5.3×10^3	Kww	5.0×10^3
Bww	8.5×10^3	Lww	3.1×10^4
Cww	1.5×10^4	Mtw	1.5×10^4
Dww	1.5×10^6	Ntw	7.0×10^3
Eww	3.8×10^5	Otw	1.6×10^3
Fww	6.6×10^5	Ptw	3.7×10^3
Gww	3.4×10^3	Qtw	1.9×10^5
Hww	7.6×10^3	Rtw	$4,6\times10^3$
Iww	8.7×10^3	Sstream	1.5×10^5
Jww	4.2×10^3	Tstream	3.7×10^4

Key: WW=Well water; TW=Tap water

Table 2: Total and Faecal Coliform Colonies Count of drinking water in Opuraja Community, Delta State, Nigeria

Samples	TCC MPN/100ml	FCC MPN/100ml	Samples	TCC MPN/100ml	FCC MPN/100ml
Aww	89	28	Kww	75	5
Bww	189	46	Lww	57	6
Cww	48	22	Mtw	44	12
Dww	30	9	Ntw	198	15
Eww	14	10	Otw	90	25
Fww	170	28	Ptw	112	54
Gww	89	25	Qtw	67	28
Hww	150	65	Rtw	78	36
Iww	81	38	Sstream	101	56
Jww	192	37	Tstream	146	32

3.5. Isolation and identification of isolates

The bacteria isolated from the drinking samples from Opuraja Community in Delta State, Nigeria were *Escherichia coli, Salmonella sp.*, *Shigella sp., Proteus* sp., *Bacillus* sp., *Klebsiella* sp., *Citrobacter* sp., *Enterobacter* sp., and *Vibrio* sp. This is in line with the report of other authors elsewhere in Nigeria. Popoola *et al.* (2007) reported similar isolates in drinking and recreational contaminated water. Okonko et al. (2008a, b) also reported the presence of some of these organisms in water samples.

The isolated bacteria species were identified to be same with those commonly encountered in water and aquatic environments (Okonko et al., 2008a). The isolation of E. *coli*, *Salmonella* sp. and *Vibrio* sp. (causative agents of gastroenteritis, typhoid fever and cholera) is a strong indication that the water samples contain pathogenic organisms and are not potable for drinking or swimming.

4.0. CONCLUSION

The presence of pathogenic and indicator organisms in these water samples render them unfit for human consumption. Water should meet different quality specifications depending on the particular uses. Thus, potable and domestic water should be harmless for the health of man and should have proper bacteriological qualities.

In summary, the drinking water in Opuraja community is highly contaminated. This is due to the indiscriminate disposal of their faecal wastes, poultries droppings and piggery wastes. And the presence of *Vibrio* sp., *Escherichia coli*, *Salmonella* sp., *Shigella* sp., and other enteric organisms call for serious concern. Education of the inhabitants on the danger of their act in respect to the way sewage is disposed and related diseases that accompany the act is therefore advocated.

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